

transient nature, speaks of it as a great flood. His flood deposits are not, however, the same as those referred to by Prof. Prestwich.

Sir Robert Ball has pointed out that if the heat received in winter is distributed over thirty-three more days, instead of only over seven more, the result would be glacial conditions in the northern hemisphere, a result which has been somewhat modified by Mr. Hobson, who pointed out that the heat received over the regions within the Arctic circle should be omitted from the calculation.

But the opponents of the astronomical theory are prepared to admit that when we are dealing with operations in which the effects are so obviously cumulative and the reaction of one on the other so important, we may expect in climate, as there are in what we call weather, times of such unstable equilibrium that, for instance, a slight prolongation of the period of cold, which may be small in itself, may yet cause a local change, the effects of which may eventually become very far-reaching—as, in the case of weather, rain may be produced by the explosion of a small quantity of dynamite in the upper regions of the atmosphere. It is useless to deny the existence of such causes as those on which the advocates of the astronomical theory chiefly rely any more than we should deny the possibility of the detection of tidal action in one of the American lakes, because we are convinced that the real cause of the rise of six feet or so of water on one side is due to the gale which we observe blowing across the lake. Nor are we justified in rejecting the possibility of more or less rapid submergences resulting in a rearrangement of surface debris or even in more cataclysmic action of the same kind, as was seen in the earthquake wave that rolled in on Lisbon.

We do seem to require some simpler theory than that of the extreme glacialists to explain the phenomena of the Pleistocene Age.

If the north-eastern portion of America and the north western part of Europe were raised so as to get a snowy mountain range on either side of the Atlantic, sending ice-sheets down to the sea in the intervening depressed trough, and by the convergence of the axes of elevation deflecting the ocean currents and causing glaciers to creep down east and west from the mountain ranges—all the phenomena of the glacial epoch could be explained.

Reverse the process; send up Greenland and lower the North American and Scandinavian chains even to below where they now stand, bringing in again the warm currents from the South, and the post-glacial submergence takes its place. Let the Icelandic volcanic system play its part, and let there be earthquakes and jerks and oscillations, all part of the regular course of operations accompanying such movements, and we have the marine drifts all explained. The forms of life which have been driven away from the centres of ice dispersal will follow the receding glaciers back again. Observers will find in their own district evidence of land ice, or of icebergs, or of sea currents, or of glacier water, but in this less cumbrous theory there will be room for all.

The conflict of views recorded in Sir Henry Howorth's exhaustive work prepares one to believe that the matter may not be finally settled for some time, and, before public opinion comes to rest, we may expect many swings of the

pendulum now far on this, now far on that side of the truth. But we welcome this protest against the extravagant views of the extreme glacialists and this valuable encyclopædia of the facts and arguments bearing on glacial phenomena which must be in the hands of every student of the subject. Our author is well known for his scientific treatment of literary subjects and for the literary skill with which he presents his scientific facts. Though he is an uncompromising advocate of what commends itself to him as the right view, he has indulged in no criticism which can be regarded as discourteous to the living or unfair to the dead.

T. MCKENNY HUGHES.

DYNAMO-ELECTRIC MACHINERY.

Original Papers on Dynamo Machinery and Allied Subjects. By J. Hopkinson, M.A., D.Sc., F.R.S. (New York: The W. J. Johnston Company, Limited. London: Whittaker and Co., 1892.)

The Dynamo. By C. C. Hawkins, M.A., A.I.E.E., and F. Wallis, A.I.E.E. (London: Whittaker and Co., 1893.)

THERE is hardly any greater authority on the subject of dynamo-electric machinery than Dr. Hopkinson. It was he who, turning his attention to the Edison machine, first showed how the iron in the magnets should be distributed, how the magnetising coils should be wound, and the machine built up so as to ensure its possessing the highest possible efficiency in every sense of the word.

This he did not attempt to do by mere theoretical speculation, though himself a great theorist, but by instituting a very complete and exhaustive set of experiments on dynamo machines under practical conditions, and graphically representing their results. No device in the whole history of the evolution of the dynamo has been of more general service than his plan of exhibiting the results of experiments in the well-named characteristic curve of the machine. This did for the dynamo what the indicator diagram had long been doing for the steam engine, though not, of course, in the same way.

With the most admirable simplicity this curve of electromotive forces as ordinates, and currents as abscissæ, gave just the information required regarding the action of the machine. Thus, when the ordinates represented the potential differences between the terminals, the inclination to the axis of abscissæ of the line joining the origin to any point gave the working resistance in the external circuit, corresponding to the current and potential difference defining the point to which the line was drawn, or, this resistance being known, gave the current and potential difference which the machine might be expected to develop with this as the working part of the circuit.

Then again, Dr. Hopkinson showed how the characteristic curve could be used to give the conditions under which an arc lamp can be made to work. It is well known that if the generating machine working on an arc lamp be run so as to give an electromotive force below a certain limiting value, the machine cannot be made to "keep" an arc. An explanation had been previously given by Dr. Siemens; but Dr. Hopkinson showed that all that was necessary was to lay down in the characteristic curve of the dynamo as already explained the line

representing the *metallic* resistance R in circuit, then draw the tangent parallel to this line, and observe whether the ordinate corresponding to the normal working current of the lamp falls on the right or on the left of the point of contact. If E denote the length of the ordinate in question, and C denote the current, we have in the former case

$$dE < RdC$$

and in the latter

$$dE > RdC$$

Thus in the former case the value of dE is smaller than the increment of electromotive force required to drive the corresponding increase of current through the metallic resistance, in the latter case it is larger than this. Consequently, in the latter case, there will be an excess of electromotive force which will go to increase the length of arc. Thus the arc will continually lengthen until the current suddenly fails and the light goes out.

Hence the mere inspection of the curve settles the question as to whether the machine is running fast enough, or whether there is a sufficient margin of speed to ensure stability.

In the paper on Some Points in Electric Lighting, a large number of facts, now so well known as to have become common places of practical science, are discussed. But ten years ago, when the paper was read, many electricians engaged in supplying electric light were themselves working very much in the dark; and Dr. Hopkinson's paper was to many of them exceedingly useful as supplying facts, and especially hints as to graphical processes of investigating the behaviour of dynamos, whether used as a generator or a motor.

The next paper is that by the author and his brother, Dr. E. Hopkinson, on Dynamo-Electric Machinery, which has become justly famous as that in which the enormously useful idea of the magnetic circuit was first applied in a complete and consistent manner to the discussion of the results of experiment on different types of dynamo. In this a comparison between the characteristic curve of the machine, and the curve of magnetising force and magnetic induction, is made to give important information as to the proper disposition of the magnetic circuit, and the failure of the total induction to pass through the armature. Further, the effect of the lead of the brushes and of the current in the armature is fully discussed and graphically illustrated; and the paper closes with what were most valuable at the time, a description of the author's method of testing the efficiency of dynamos, and numerous results of experiments on machines with armatures wound according to the Hefner Alteneck plan, and the unsymmetrical horseshoe arrangement of magnets, and on others with Gramme armatures and the Siemens rectangular symmetrical arrangement of magnets. In these efficiency experiments the ingenious plan of using two similar machines in the same circuit and having their shafts coupled, one acting as generator, the other as motor, was first adopted. The motor in great measure drives the generator which feeds it, and it is only necessary to supply by means of a belt the balance of driving power required. Thus, uncertainty in dynamometric measurement of power transmitted has effect only on the estimation of this balance. The power developed by the motor can be found

electrically, as likewise the electrical energy developed by the generator, and thus all the data are obtained for estimating the efficiency of the machine.

This idea has borne important fruit in the extremely valuable methods which have been invented by others for more conveniently carrying out similar dynamo experiments, and for testing transformers.

Next comes the very valuable continuation of this paper published only last year, which completes the discussion of direct current machines. In this sequel the effect on the electromotive force of the machine of the current in the armature for a given lead of the brushes is experimentally investigated, and compared with its theoretical value as given in the earlier part of the paper.

The remaining portion of the book consists mainly of papers relating to the theory of alternating currents, and the testing of alternate-current machines and transformers, and concludes with an account of the author's arrangements for applying the electric light to the light-houses of Macquarie and Tino. The first paper on alternating currents is the one which has been so much referred to in recent discussions on the action of alternators, and the possibility of running more than one in the same circuit.

Though the increased use of alternating currents has added much to our knowledge of the behaviour and capabilities of alternators, Dr. Hopkinson's paper is, and will remain, one of the classics of the subject. But the last word of theoretical and practical explanation has not yet been said, and will probably not be said for a long time. In the meantime there is a possibility, now that the behaviour of iron in rapid magnetic cycles can be studied completely in various ways, of our obtaining further information which may clear up some of the outstanding difficulties of the subject.

Some results of a very interesting character as to rapid cycles are given in the paper on the Tests of Westinghouse Transformers. The curves showing the electromotive force and the current at different instants during a half period are plotted and come out very considerably different from the ordinarily assumed curve of series. The harmonic analysis, or the new analysing machine of Henrici and Sharpe, might with advantage be applied to them to reveal their components. From these curves the dissipation loops are plotted and made to give the loss of energy due to local currents and hysteresis in the curves.

Further description of these papers is unnecessary. They have already passed to a considerable extent into electrical literature; but a great service to practical electricians has nevertheless been done by their publication in a collected form.

In Messrs. Hawkins and Wallis's book we have little of originality; but what seems a straightforward, accurate, and fairly full account of dynamo-electric machinery. Beginning with chapters on the Magnetic Field, the Magnetic Circuit, the Production of an E. M. F., and Self-Induction, the authors enter on their main subject with a chapter on the Classification of Dynamos. The principal types of machine are described and well illustrated, so far as the number and general nature of the cuts are concerned. But while the authors have been liberal with carefully made drawings and well considered diagrams, the execution and printing of the illustrations in the text

are here and there rather poor, and a higher general standard in this respect might easily have been attained.

After a general analysis, so to speak, of dynamos, in which armatures, magnets, &c., are discussed, we come to matters relating to the action of dynamos, such as series, shunt, and compound winding, and sparking and angle of lead of brushes. Then follow descriptions of typical machines, illustrated by folding sheets, and the book closes with chapters on Dynamo-Designing, and the Working and the Management of Dynamos.

We should have liked to have seen dynamo-testing worked out more fully, and a separate chapter on this important subject might easily have been given without burdening the book with matter properly belonging to works on general electrical measurements.

Considering the compass of the book—520 small 8vo pages—the authors have succeeded in placing before their readers a very great amount of valuable information, well arranged and clearly expressed, and their work will no doubt be appreciated by students and workers in practical electricity.

A. GRAY.

OUR BOOK SHELF.

Modern Microscopy: a Hand-book for Beginners. In two parts. 1. "The Microscope, and Instructions for its Use." By M. J. Cross. 2. "Microscopic Objects: how Prepared and Mounted." By Martin J. Cole. (London: Baillière, Tindall, and Cox, 1893.)

THIS book, although only extending to 104 pages, is what it professes to be, and will prove thoroughly useful to beginners. The authors understand practically their respective subjects, and this has given the capacity, never otherwise possessed, to tell the beginner accurately and efficiently what it is needful for him at the outset to know.

It is highly to be commended that they have not rendered their pages incompetent by any pretence at an introduction to the optics of the instrument, or concerned themselves with any attempt at exposition of modern optical theory. They have done what affords a more genuine evidence of their appreciation of the importance of these subjects, having presented the results of the study of them in a practical form to the beginner, so that although his earlier efforts are not complicated with mathematical demonstrations and theory, he is nevertheless taught to work, on the highest results reached through these, so far at least as they apply to his initial endeavours.

The danger of extremely elementary books on microscopy is shallowness. They have often been a mere catalogue of two or three chosen instruments, with brief accounts of the apparatus affected by the author, and descriptions of pretty or pleasing objects. The former part of this book is much more than this; it gives the results of a practical knowledge of how to employ the instrument in such a way as to attain the finest results; always remembering that it is beginners that are receiving the instruction.

There are some thoroughly sensible things said on the microscope-stand. We may differ slightly from some of these, but they are written with a knowledge of the subject, and those who follow them will not greatly err.

We can commend also the chapter on "Optical Construction." It is brief, but puts to the beginner exactly what he requires to know. The pages on "Illuminating Apparatus" are specially commendable because thoroughly experimental. In fact, the fifty-five pages devoted to modern microscopy will be a boon to every one of the many who are every year "beginning" with the use of the microscope.

But the practical character of the book is seen even more clearly in the second part of it, by Mr. Martin Cole.

He at once introduces the tyro to the art of preparing and mounting his own objects. Here again it is not a mere repetition of what has been obtained from other sources that is presented, but Mr. Cole's long experience as a mounter is given to the reader unostentatiously and with pleasant and useful brevity.

There are some who, glancing at this little treatise, will at once conclude that the thirty-six pages devoted to the subject must leave it inefficiently treated even for beginners. We advise such to read the pages; and after some years of practice in most of the departments of mounting referred to and explained, we can only say that they present in a brief but a very efficient manner the facts required to enable the earliest efforts of an earnest amateur to become so successful as almost certainly to secure his interest in the subject, and cause him to intelligently pursue his pleasure and instruction, if not to aim at scientific work directed by more exhaustive treatises.

W. H. DALLINGER.

Lectures on Sanitary Law. By A. Wynter Blyth, M.R.C.S., L.S.A. (Macmillan and Co. 1893.)

THIS work presents a general view of the powers and duties of Local Authorities in relation to public health, and since the material has been compiled by one who, while he is a prominent sanitarian is also a barrister-at-law, the fact that the work is good and trustworthy, and leaves but little to be desired, goes without saying. The only point upon which there is any scope for adverse criticism is that the review of sanitary legislation appears to be, in places, a little too cursory, and in consequence some important material is a trifle too hurriedly passed over. To indicate one such instance:—There is some important material contained in the Dairies, Cowsheds, and Milkshops Orders of 1885 and 1886 which is not given, and with which the health-officer is directly concerned. Sections 10, 11, and 12 of the 1885 Order are omitted; and no one will question their right to be fully included within any serviceable abstract of the Order, since they deal specifically with certain well recognised sources of contamination, against which it is necessary to guard the milk in those places where it is stored or kept for sale.

Nothing need be more inclusive or better expressed than the majority of the work, and when in one or two places the information is a little more extended, and the statutes specially dealing with the inspection and examination of food (which are now given *in extenso* in the appendix) are incorporated in, say, another two chapters, the book will be rendered even more acceptable than it is at present to those desirous of obtaining in a readable and concise form a good knowledge of sanitary legislation.

The scope of the book embraces the entire range of public health legislation, and the volume is largely an embodiment of a series of lectures which have frequently been given by the author. The first chapter treats of the constitution of Sanitary Districts and Authorities, and includes the definitions of certain terms employed in the Sanitary Acts. Lecture ii. deals with the statutory provisions regarding nuisances; and the next three lectures are concerned with the legal aspect of sewerage and drainage, water-supply and sanitary appliances; regulations and bye-laws; port sanitary law, canal boats, Metropolitan sanitary law, the Housing of the Working Classes Act, 1890, are all dealt with in subsequent chapters; and the statutory provisions which deal with the prevention of disease are particularly well and clearly mapped out in Lectures vi. and vii. The book comprises nearly 300 well-printed pages, and it is neatly and serviceably bound.

The author must be congratulated upon having presented a rather heavy and unattractive subject in the most concise and readable form—consistent with general usefulness—of any in which it has hitherto appeared.